RESEARCH

Cariboo Forest Region

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EXTENSION NOTE #22
September 1997

Progress Report on Group Selection Systems for High Elevation Forests in the Cariboo Forest Region

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INTRODUCTION

This extension note documents progress to date on the group selection silvicultural systems research trial in the Engelmann spruce-subalpine fir subzone (ESSFwc3), near Likely, B.C. Background information on this project is described in Extension Notes #9 and #14.

OBJECTIVES

The primary objective of this study is to develop a forest management system that will provide a basis for a viable timber harvesting system and also maintain suitable caribou habitat. The specific objectives are:

1. to assess whether a group selection system for high elevation ESSF sites is a viable silvicultural system to maintain caribou habitat and old growth characteristics in managed forests;
2. to assess whether a group selection system for high elevation sites will minimize the risk of blowdown and the incidence of pests and disease;
3. to assess the effectiveness of natural and artificial regeneration treatments within a group selection system in high elevation ESSF sites;
4. to assess the effects of changes to soils, snow accumulation and melt, small mammal populations and bird populations;
5. to provide extension opportunities in the form of demonstrations, research reports and high elevation management guidelines to operational foresters.

HARVESTING

Four blocks, averaging 40 ha each, were harvested using three treatments of different opening sizes: 0.03 ha (small), 0.13 ha (medium) and 1.0 ha (large). The target volume removal for each treatment was 30%, including skid trails, but exclusive of roads and landings.

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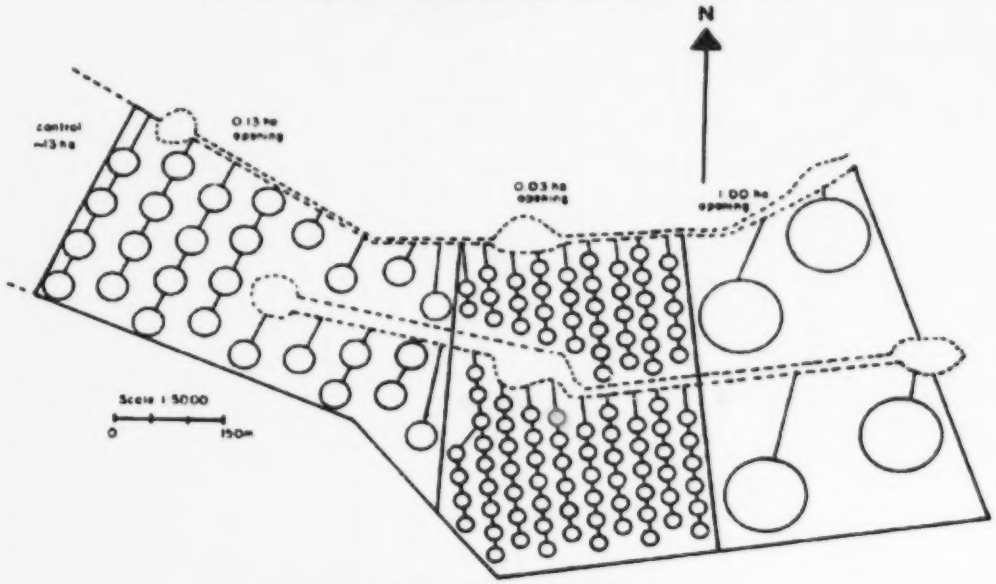
Figure 1
Schematic layout of the harvesting treatments within a site



Two sites are situated in the Blackbear Creek drainage ranging in elevation from 1370 to 1550 m (Blackbear Summer and Blackbear Winter), while the other two sites (Upper Grain Creek at 1460 to 1680 m in elevation and Lower Grain Creek at 1525 to 1740 m in elevation) are located in Grain Creek drainage. Three sites were harvested in winter, 1992/93, while the fourth site (Blackbear Summer) was harvested in the summer of 1992. A clearcut adjacent to and harvested at the same time as Blackbear Summer was designated the 'control' harvesting treatment for the purposes of assessing artificial regeneration success.

STRUCTURE, DYNAMICS AND REGENERATION ECOLOGY

An understanding of the structure and dynamics of natural stands and the regeneration patterns of tree species in these stands is required for interpreting the implications of selection system practices for long-term stand development. Stand structure and regeneration data were collected prior to tree harvesting from 24 sample locations on each of the three winter harvested research sites. At each sample location, all trees, including germinants, were recorded by species, height, stem diameter, vigor class, and age. In addition, seedbed characteristics (materials and microtopography) were recorded for each regeneration stem (<7.5 cm dbh) and the proportion of the total plot area covered by different seedbed materials was assessed. The volume of coarse woody debris and its size and degree of decomposition was also recorded at each sample location.

Tree age structure analyses suggest that Engelmann spruce established a young forest canopy on each site following a wildfire, or other stand destroying disturbance. Once the canopy had developed, however, subsequent establishment and survival of spruce stems was significantly reduced and few spruce stems currently grow into the mature canopy. Subalpine fir dominates the advance regeneration of mature stands and has a classic negative exponential age distribution, typical of climax species. The distribution of spruce regeneration suggests that

it strongly prefers exposed mineral soil and well decomposed rotting wood that is raised above the general forest floor. Subalpine fir regeneration is most common on mineral soil and rotting wood, but occurs more frequently than spruce on undisturbed forest floor materials.

MICROCLIMATE DATA

Dataloggers were established to collect climate data in the "small", "medium" and "large" openings and the uncut control. The measurements include: relative humidity, precipitation, wetting and drying cycles and air and soil temperatures at different locations. Soil and air temperatures were taken across all three openings at set intervals in four directions (N,E,S,W) to determine if there was much variation within the openings. Climate data is also being collected for the five different planting sites on the three opening sizes and on a nearby clearcut.

Results:

Precipitation is frequent, on average every 3 to 5 days with rainless periods of more than a week being rare.

Relative humidity may drop to 30 - 60% during the day , but always returns to 100% in the night.

Wetness grids indicated that the forest canopy is continually wetting and drying.

At 15 cm soil depth, the temperatures only varied by 1 to 2 degrees between opening sizes, with the largest openings being the warmest and the smallest the coolest. Soils at south and west aspects within all opening sizes were warmer. Small differences in air temperature were also observed.

Soil temperature was higher on all planting treatments compared to the control microsites. The highest temperatures were found on the mound and the screefed sites.

The most dramatic treatment effect was on the length of the growing season. Large openings were snow free earliest, with corresponding soil temperature increase.

WINDTHROW

In 1993, 1224 trees were permanently marked along transect lines, which crossed all the treatment units in the four replicate sites. There were approximately 80 trees per treatment unit. The trees were marked immediately after the harvesting was finished in March and represented pre-harvest stand conditions. The trees along the transect lines were re-assessed for decay condition, lichen abundance and position (standing/fallen) at the end of August, 1997.

Forty three trees have fallen since 1993, representing 3.4% of the total number of trees marked. The majority (81%) of the trees were dead prior to falling. Windthrow has had a large impact on the standing dead component of the stand with 14.6% of the marked standing dead trees now fallen. In contrast, the live component of the stand is very stable with only eight of 981 trees fallen (0.8%). Data from all the sites were pooled by treatment to check for trends. The least windthrow occurred in control areas (2.6%) compared to the "small" (3.2%), "medium" (4.1%) and "large" (4.2%) openings.

In summary, windthrow has been very light and variable across the four study sites and treatments. Windthrow should not be considered an obstacle to implementing group selection silvicultural systems.

NATURAL REGENERATION

Natural regeneration ingress of Engelmann spruce and subalpine fir is being assessed on the three opening size treatments to determine if natural regeneration of tree species may be a viable option for reforestation of harvested openings. Density of natural regeneration ingress has been monitored annually on 1,164 plots in three harvesting treatments and four silviculture treatments. The effects of the following factors on regeneration density are being analyzed: harvest group size, seed rain, seedbed characteristics, and advance regeneration density and vigor.

Vegetation development was monitored on all natural regeneration plots. Mortality and growth of advance regeneration was assessed on selected plots.

A manual seeding experiment was repeated again this year to test if seed supply significantly limits natural regeneration ingress. Two scarification treatments (scarified and not scarified) and two seeding treatments (hand seeded with spruce and subalpine fir and not

seeded), for a total of four treatments (scarified/seeded, scarified/not seeded, not scarified/seeded, and not scarified/not seeded) were applied to 128 (1 m x 1 m) plots in each opening size treatment at each of the three sites. Seed traps, set out on a grid system, were monitored annually to assess natural seed rain and its variation with distance from stand edge and from year to year.

Preliminary analysis of the data indicate that natural seed rain is highly variable from year to year and is generally poorer at the high elevation Grain Creek sites, compared to the lower elevation Black Bear site. "Small" and "medium" sized openings have greater natural regeneration densities than do the large opening, due primarily to the decline of subalpine fir regeneration with distance from stand edge in the large openings. Scarified sites had much greater regeneration densities than did non-scarified sites. Hand seeding contributed little to regeneration densities at the low elevation Black Bear site, but resulted in increased densities at the higher elevation Grain Creek sites. Advance regeneration also contributed significantly to regeneration densities at the high elevation sites, but not at the Black Bear site.

These preliminary results suggest that natural regeneration ingress may regenerate "small" and "medium" sized group selection openings at low elevations of the ESSFwc3 if exposed mineral soil is present in the spring following a good cone crop (seed rain). Natural regeneration of harvested stands appears to be much less reliable at higher elevations of the ESSFwc3.

ARTIFICIAL REGENERATION

Three native species, *Pinus contorta* (lodgepole pine), *Picea engelmannii* (engelmann spruce) and *Abies lasiocarpa* (subalpine fir) were chosen for planting on the trial sites. Spruce and subalpine fir are the predominant conifer species throughout this subzone. Pine is more common at the lower elevations of the subzone, but is sparse at higher elevations.

Five planting treatments were tested. These treatments include protected sites, natural raised sites, rotten wood, mechanized scarification and a control (standard grid planting).

Seedling assessments were

Table 1

Significant Seedling Growth Differences Between Opening Sizes by Species

		Opening Size		
Variable	Species	Large	Medium	Small
Total Height Growth	Bl	11.7	10.1	9.0
(cm)	Pl	22.6	16.0	13.6
	Sx	14.0	12.1	10.5
Leader Growth (cm)	Bl	4.8	3.6	3.0
	Pl	9.1	6.0	4.5
	Sx	5.0	4.3	3.2
Total Diameter Growth	Bl	1.8	1.3	1.0
(mm)	Pl	3.7	2.3	1.8
	Sx	2.1	1.6	1.1
Diameter Growth 1996	Bl	0.98	0.61	0.58
(mm)	Pl	1.7	0.93	0.77
	Sx	0.98	0.63	0.60

completed in the fall of 1993, just after the seedlings were planted and in the fall of 1994, 1995 and 1996. Seedling height, leader length, diameter, condition, damaging agents and vegetation cover were assessed.

A summary of the findings from the three winter logged sites to date includes:

Harvesting Treatments:

Overall seedling performance decreases with reduced opening size (Table 1) and increases in elevation.

Results from the summer harvested group selection trial are similar to those observed in the winter harvested group selection.

Seedling growth on the clearcut is presently less than found on the large group selection treatments. Due to problems regarding establishment on the clearcut, this data will need confirmation.

Lower amounts of terminal damage were observed on the large openings and the clearcut.

Species

Pine appears to perform well; however, it is at the upper limits of its elevation range and caution should be used in interpreting the data after only three growing seasons.

Pine has lower survival and poorer condition at the Lower Grain Creek site in the small openings compared to the other species. It also has higher rates of terminal damage in the "medium" and "small" openings. Overall more pine seedlings have bent stems. Conversely due to the superior height growth, there are more pine seedlings free of vegetation competition.

Spruce is found more commonly at the higher elevations and although seedling growth is lower, the survival and condition is equal to or better than pine. Juvenile growth of spruce is usually slower than pine, but it increases with age. Also, this is the only species that did not have significantly lower growth in the "medium" compared to the "large" openings. If this trend continues it may allow for more flexibility in logging treatments if spruce is used to reforest the site.

Subalpine fir seedlings may also have potential on these sites.

Figure 2

Third Year Seedling Growth by Planting Treatment

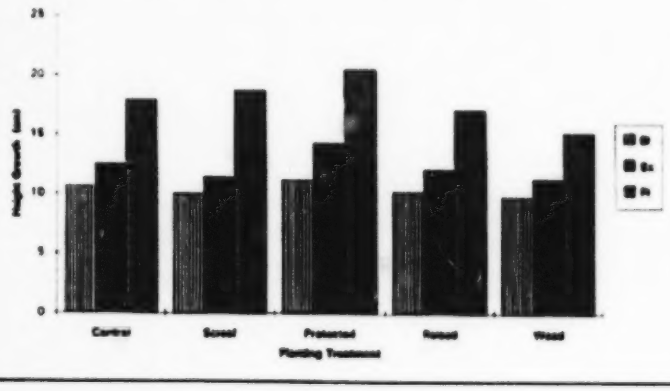
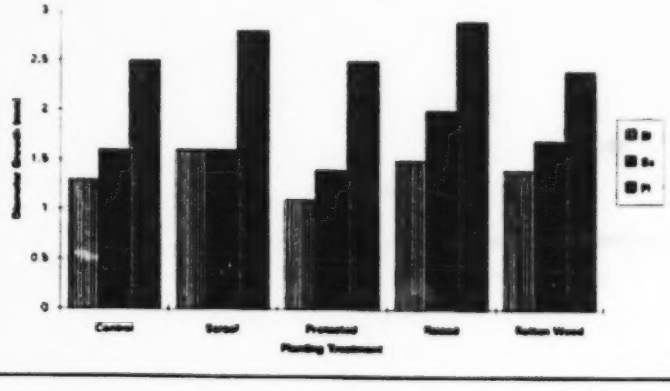


Figure 3

Mean Total Diameter Growth



They are presently smaller than the spruce, or pine, but the 1996 growth data indicates that the current subalpine fir growth is not much lower than spruce. There is little experience in planting subalpine fir, so estimating future response is not possible. The subalpine fir seedlings seem to prefer the "large" openings, which may restrict choices in logging treatments.

Planting Treatments

After three growing seasons, the best overall planting treatment appears to be the raised sites (Figures 2 and 3). These seedlings had larger diameters, which is desirable on these sites to withstand the snow loading and movement.

The survival is highest on both the rotten wood and the raised sites, but the growth on the rotten wood was generally poor, especially height growth.

The protected sites produced etiolated seedlings across all species which is not desirable; however, this condition may change with time as the seedlings become taller than the obstacle they are planted behind.

Seedling performance on the control was always poorer than other treatments, although not usually the worst.

The seedlings planted on the screefs performed better than average except for spruce seedlings, which did not grow well on this treatment.

The highest number of bent stems were observed on the control in both the clearcut and the group selection project.

Screefing reduced vegetation competition for two additional growing seasons compared to the other planting treatments.

HYDROLOGY

A sampling design for repeated measurements of snow depth and water equivalent was developed to spatially represent measurements. Snow stakes were installed (40 stakes per plot) in the control and treatment units at three sites (11 plots in total).

Seven repeated measurements of snow depth and water equivalent per year were obtained from all plots in the Blackbear Summer logged and Blackbear Winter logged sites during the 1994, 1995, 1996 and 1997 field seasons.

In the spring of 1994, snow depths were so great at the Lower Grain Creek site that many of the 10 foot bamboo poles were not visible, thereby making it impractical to implement the intended sampling design. This site was dropped from the snow survey program due to logistical and safety considerations.

The snow surveys at the two Blackbear sites have shown that snow accumulates and melts very differently from one year to the next. There are also large differences between plots that are probably due to geographic effects (e.g. wind and aspect) rather than silvicultural treatment. Thus far, the effects of 30 percent volume removal on snow accumulation and melt have been small compared with the other sources of variability. The effects within "medium" and "large" openings are significant and are consistent with other reports in the literature.

Other progress includes canopy measurements in an attempt to explain the variability in snow at individual points and the operation of snowmelt lysimeters.

ARBOREAL LICHEN - GROWTH RESPONSE

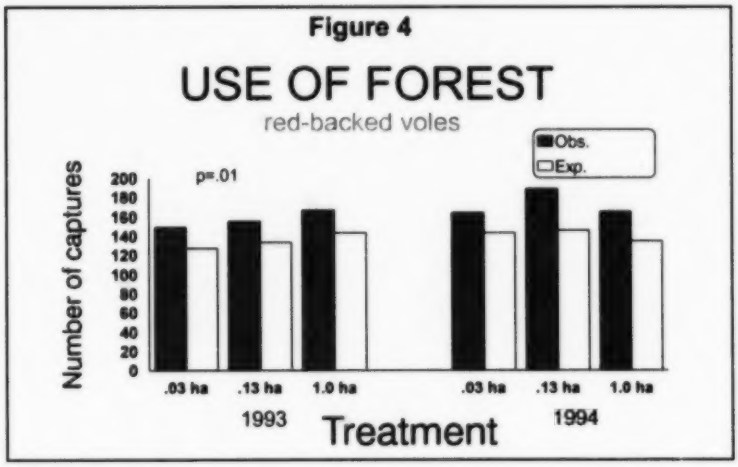
Persistent deep snow pack in these high-elevation forests results in a caribou ecotype dependent upon arboreal lichens for winter forage. Consequently, the conservation of forage lichens is an important objective for silvicultural systems intended to maintain habitat for caribou. To investigate this aspect of silvicultural systems, a methodology was developed to assess the growth response of arboreal lichens to changes in microclimate resulting from partial cutting. Two species of "beard" lichens were studied in this context—*Bryoria fuscescens* and *Alectoria sarmentosa*. The initial study results indicate a reduction in the growth rate of lichens by approximately 15% following the first pass of harvesting. Of the three treatments evaluated—"small", "medium", or "large" openings—lichen growth was usually greatest within the "small" openings treatment. Papers are being prepared that describe this new methodology and the results of these studies.

ARBOREAL LICHENS - DISTRIBUTION AND ABUNDANCE

The abundance of arboreal lichen within the caribou feeding

zone—up to 4.5 m above ground—was visually estimated on 1220 trees occurring along transects established across four study sites. Twenty percent of the trees along the transects were dead, and they supported about 12% of the total lichen biomass observed. Spruce trees, both alive and dead, supported 18% of the total lichen biomass, which was proportional to their representation in the stand. More than half of all living trees were small subalpine fir (10-30 cm dbh), which contained 47% of the total lichen biomass. The mid-size class of live subalpine fir (31-50 cm dbh) had the most lichen per tree.

Figure 4



BIODIVERSITY STUDIES

There are three biodiversity studies within the research project. Two of the studies document both community and individual species response to the harvesting treatments. One is on small mammals and the other is on breeding birds. The third study is a retrospective study which examines differences between breeding bird communities in three seral stages: young (10-30 yrs.), pole (60-120 yrs) and old (>140 yrs). The clearcutting silvicultural system is commonly used in the portion of the ESSF outside of caribou habitat. There will be implications to biodiversity as the seral stage distribution on the landscape shifts from predominantly old forest to younger seral classes. The implications of both silvicultural systems to biodiversity can be compared.

Small mammal studies were conducted for one year prior to harvest and for two years after harvest using a live trapping method. Grids of 48 Longworth traps were laid out in each treatment unit per site so that one third of the traps were in openings and two thirds in the adjacent forest. The ESSF has a rich and abundant small mammal community. Nine species were trapped during the study in the following order of abundance: red-backed vole, cinereus shrew, dusky shrew, deer mouse, long-tailed vole, meadow vole/ heather vole, western jumping mouse and ermine. Overall, there were no treatment effects on the small mammal community in terms of abundance, diversity or evenness within the study sites. Because red-backed voles dominated the small mammal community (58 to 79% of total captures), they were analyzed separately. Again, there were no significant differences in use of the partial cutting treatment units and unlogged controls. However, when the data were separated by opening and forest within each partial cutting treatment, there is clear preference for the forested areas of the treatment units, irrelevant of opening size, in both post treatment years (Figure 4).

In the group selection silvicultural system trial, breeding bird communities were researched for one year prior to harvest and for five years following harvest. Intensive spot mapping (to attain absolute density) was done for one year pre and post harvest while the point count survey method (to measure relative density) was used to monitor annual population changes and detect any major responses to the harvesting treatments. The bird community is very rich and abundant in the ESSF, especially compared to the drier subzones in Cariboo Region. There were 39 species recorded on our research sites of which 22 were assumed to be breeding. Based on the first post-treatment year of spot mapping data, there were no significant differences between the harvesting treatments for richness, abundance, or diversity. There were some differences at the species level where hermit thrushes and dark-eyed juncos

preferred the "large" and "medium" opening treatments, and varied thrushes and Swainson's thrushes preferred the unlogged controls to any treatment. The composition of the breeding bird community in the treatments have not changed dramatically from year 2 to 5 though some new species have been noted on the site: blackbacked woodpeckers due to increased coarse-woody debris; MacGillivray's warblers, orange-crowned warblers and fox sparrows due to increased shrub along roads and in openings; and olive-sided flycatchers due to increased forest/opening edge. The finding to date is that the group selection silvicultural systems, particularly the "small" and "medium" openings, based on 30% volume removal and 80 year cutting cycle substantially retain old forest bird communities.

The retrospective seral stage study was located on four sites throughout the ESSFwk1. Point count surveys were conducted in the three seral stages: young (10-30 yrs), pole (60-120 yrs) and old (>140 yrs), three times through June, 1994. The bird communities were very similar in terms of species richness, abundance and diversity; however, the young forests strongly differed in species composition from the other two stages. Species such as dark-eyed juncos, chipping sparrows, Lincoln's sparrows, warbling vireos, alder flycatcher, and orange-crowned warblers were very common in the young stands compared to older stands. In old forests, Townsend's warblers, golden-crowned kinglets, varied thrushes and winter wrens were most common. Although the bird community composition was very similar between pole and old forests, there were a few species, such as the winter wren and varied thrush, which were significantly more abundant in old forests. Various habitat attributes such as coarse woody debris, basal area by size class of trees, crown closure, vegetation, number of wildlife trees by size class and a canopy diversity, were measured then correlated with bird abundance. Total basal area and canopy diversity strongly effected the abundance of many species. Results of this study were used to project changes in abundance under different biodiversity options relative to the seral stage distribution in the pre-industrial landscape. There will be large declines in species such as the three-toed woodpecker, boreal chickadee, brown creeper, winter wren, golden-crowned kinglet, varied thrush and evening grosbeak, in landscape units with a low biodiversity emphasis. The bird communities in the old forests of the ESSFwk1 subzone were very similar in composition to those in the research sites located in the ESSFwc3. Group selection silvicultural systems should be considered as an option in the portion of the ESSF outside of caribou habitat as means of retaining old forest habitat.

ADAPTIVE MANAGEMENT

The Cariboo/Chilcotin Land Use Plan specifies that a final caribou strategy, including a description of modified harvesting for caribou range, be completed by December 31, 1999. Adaptive management is necessary to achieve a workable silvicultural system by this deadline. This approach will also allow many of the operational concerns to be addressed. A large scale adaptive management project is being planned in the Mount Tom area of the Quesnel District.

SUMMARY

This silvicultural systems trial is specifically focused on producing a tested system, which will maintain caribou habitat while allowing for timber harvesting. To succeed it must be ecologically and silviculturally sound, as well as operationally viable. Although much work still needs to be done, this research is well on the way to providing managers with another integrated management tool for high elevation forests.

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